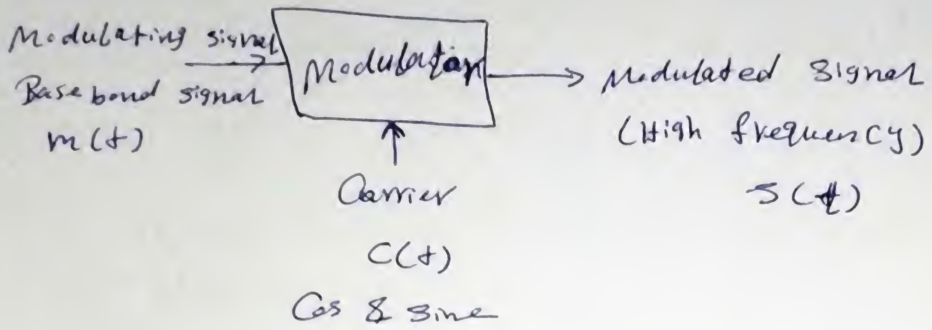
٣/١٠ — Amplitude Modulation — اتساع

Lec5

AM wave



$C(t) = A_c \cos(2\pi f_c t + \varphi) \Longrightarrow$ Carrier wave

$C(t) = A_c \cos(2\pi f_c t)$ in AM wave

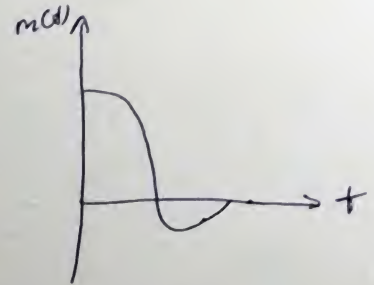
* Types of modulator

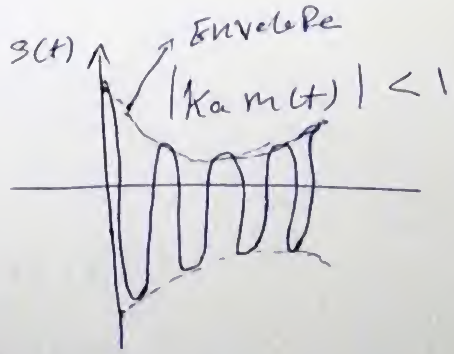
[1] $s(t) = A_c[1 + k_a m(t)] \cos(2\pi f_c t) \Longrightarrow$ AM wave

$$= \underset{\downarrow \; C(t)}{A_c \cos(2\pi f_c t)} + k_a A_c\, m(t) \cos(2\pi f_c t)$$

$$C(t) + k_a\, m(t) * C(t)$$

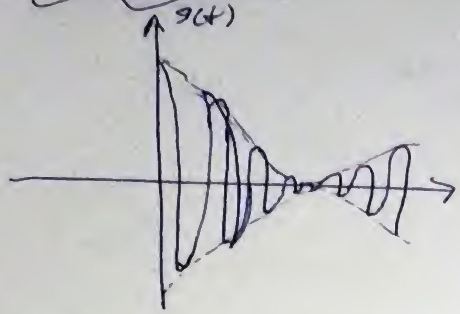
$k_a \longrightarrow$ amplitude sensitivity of AM wave





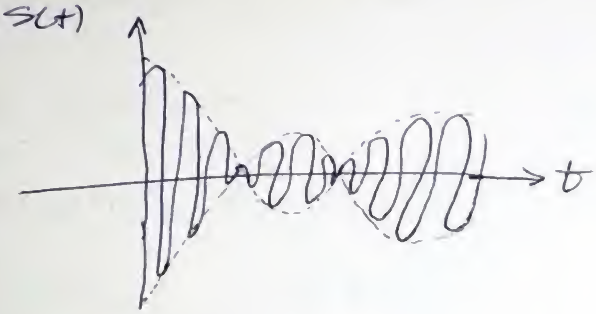
AM wave in time domain

* if $|k_a m(t)| = 1$



* overlap

* if $|k_a m(t)| > 1$



* overmodulation

$|k_a m(t)| < 1$ ⇐ أفضل حالة هي الحالة الأولى ←

ولكي نرجع $m(t)$ في الرسيفر (نعمل recover) .

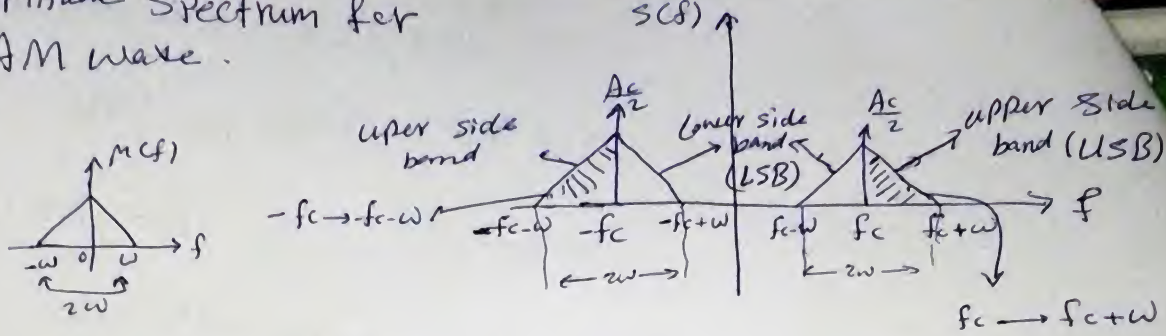
Percentage Modulation $= |k_a m(t)| * 100$

*
$$S(f) = A_c\left[\cos(2\pi f_c t) + k_a A_c * m(t) \cos(2\pi f_c t)\right]$$

$$= \frac{A_c}{2}\left[\delta(f-f_c) + \delta(f+f_c)\right]$$

$$+ \frac{k_a A_c}{2}\left[M(f-f_c) + M(f+f_c)\right] \qquad m(t) \rightleftharpoons M(f)$$

* Amplitude spectrum for AM wave.



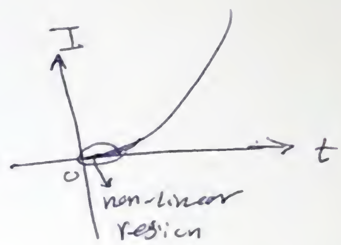
* Transmition BandWidth for AM wave = 2W

W ⇒ Baseband frequency

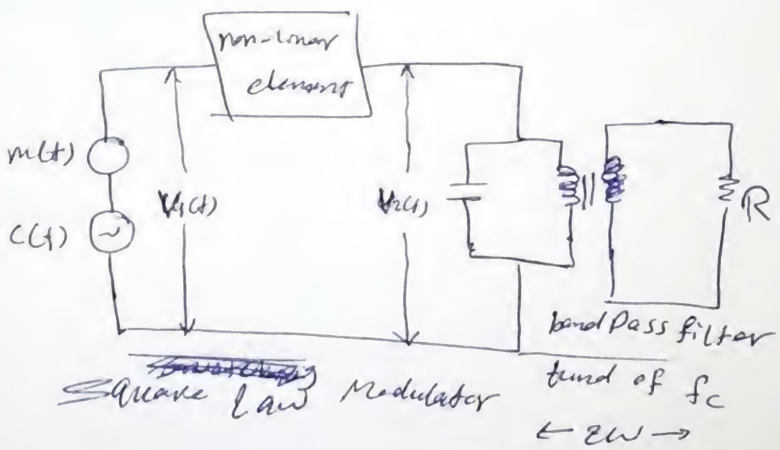
* AM modulator:

(1) Square-law Modulator

(2) Switching - Modulator



1- square-law



~~Switching~~ Square law Modulator

$$V_1(t) = m(t) + c(t)$$
$$= m(t) + A_c \cos(2\pi f_c t)$$

$$V_2(t) = a_1 V_1(t) + a_2 V_1^2(t)$$

$$V_2(t) = a_1[m(t) + A_c \cos(2\pi f_c t)] + a_2[m(t) + A_c \cos(2\pi f_c t)]^2$$

$$= a_1 m(t) + a_1 A_c \cos(2\pi f_c t) + a_2 m^2(t) + 2a_2 A_c m(t) \cos(2\pi f_c t) + a_2 A_c^2 \cos(2\pi f_c t)]$$

$$S(t) = A_c[1 + k_a m(t)] \cos(2\pi f_c t)$$

$$V_2(t) = A_c\,[a_1 + a_2 m(t)] \cos(2\pi f_c t) + a_1 m(t) + a_2 m^2(t) + a_2 A_c^2 \cos^2(2\pi f_c t)]$$

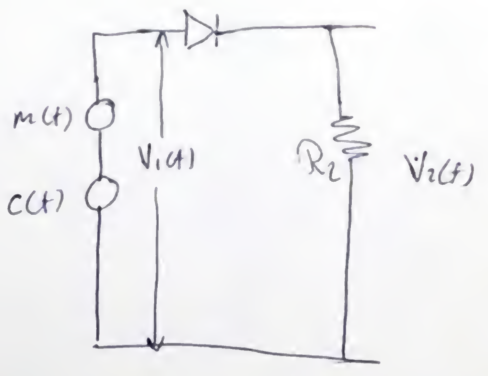
Output of BPF:-

$$= \underbrace{A_c a_1 [1 + \underbrace{\frac{2a_2}{a_1}}_{k_a} + m(t)] \cos(2\pi f_c t)}_{\text{AM wave}}$$

* ———— * ———— * ———— *

(2) Switching modulator:-

Diode → Ideal Case



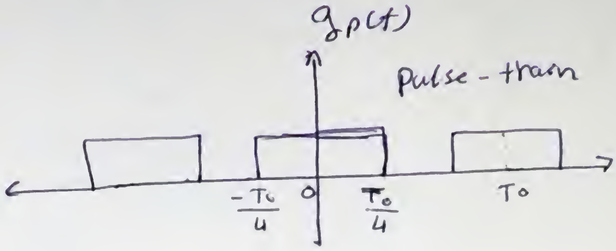
Switching Modulator

$V_1(t) = A_c \cos(2\pi f_c t) + m(t)$

* $C(t) \geq 0$ Diode on

* $C(t) < 0$ Diode off

$$V_2(t) = \begin{cases} V_1(t) & c(t) > 0 \\ 0 & c(t) < 0 \end{cases}$$



$V_2(t) = V_1(t) - g_p(t)$

$T_0 = \frac{1}{f_c}$

$$g_p(t) = \frac{1}{2} + \frac{1}{\pi}\left[\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2^{n-1}} \cos\left[2\pi f_c t\,(n-1)\right]\right]$$

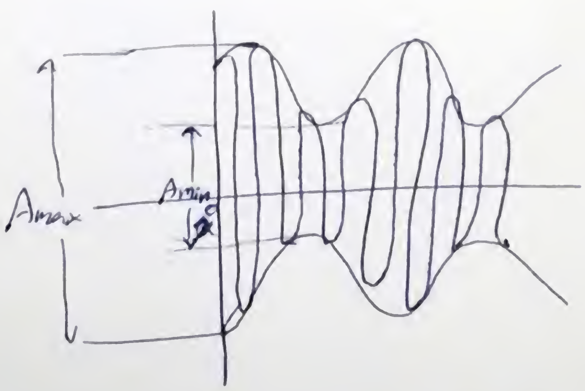
$n = 2$

$n > 2 \Rightarrow$ Project by BPF

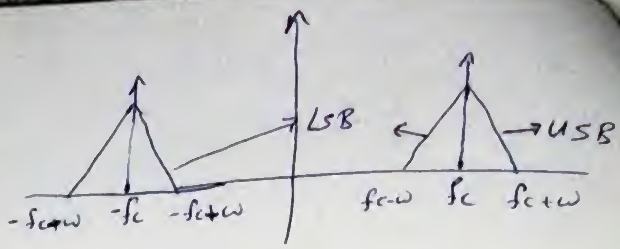
$$V_2(t) = \frac{A_c}{2}\left[1 + \frac{4}{\pi A_c} m(t)\right] \cos(2\pi f_c t)$$

* Modulation Index:..

$$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$$



$$P_c = \frac{A_c^2}{2}$$



$$P_{LSB} = \frac{1}{8} \mu^2 A_c^2$$

$$P_{USB} = \frac{1}{8} \mu^2 A_c$$